# APPENDIX A – BENEFIT-COST ANALYSIS DISCUSSION

# I. Introduction

A Benefit-Cost Analysis (BCA) was conducted for *Access I-95: Driving Baltimore City's Development*. The project will improve access to and from I-95 and the connecting roadway system in the vicinity of the Port Covington redevelopment project. The Port Covington project is located on 266 acres on the tip of the south Baltimore peninsula. This infrastructure is critically necessary to support the significant economic growth expected from the Port Covington redevelopment, which is already underway, and protect the surrounding communities as well as the economic efficiency of the city, state, and region. The project is located in the 3rd Congressional District and is within Baltimore City, two miles south of Baltimore's central business district. Port Covington has a high Vulnerable Population Index (VPI) when compared to the regional VPI and the VPI for Baltimore City.

The BCA provides monetary benefits and costs, in present day dollars, associated with the project over a 40 year analysis period. The estimated benefits have been categorized by the five long-term outcomes listed in the BCA Resource Guide as follows: State of Good Repair, Economic Competitiveness, Quality of Life, Environmental Sustainability, and Safety(1). An effort was made to comply with all BCA guidelines and a conservative approach has been used for all assumptions.

# II. Project Summary

As described in detail in the Project Narrative, the Port Covington redevelopment project will revitalize 266 acres of under-utilized industrial land. The Port Covington site is located on a peninsula bound by I-95 and the Middle Branch of the Patapsco River. Without critical infrastructure improvements for access to and from I-95 and the connecting roadway system, it is likely that the traffic produced by the development will cause disruptions and delays that will adversely impact operations at the Port of Baltimore and the neighboring communities. Specifically, additional delays without this project are projected to be in excess of 61,000 person-hours per year on Hanover Street approaching the I-95 Southbound on-ramp, and 349,000 person-hours per year on the I-95 Southbound off-ramp to McComas Street/Key Highway. Increased traffic on the Key Highway off ramp is also projected to queue the full length of the existing ramp, seriously impacting mainline traffic on I-95 including local and regional freight and commuter traffic. The multi-year redevelopment project will create thousands of jobs, enhance connectivity and opportunities for several disadvantaged groups, build green spaces and parks, preserve and further enhance public access to the waterfront, provide outdoor recreation opportunities and bring significant long-term economic benefit to the City of Baltimore, the state and the region, but the infrastructure improvements included in the *Access I-95* project are needed to help the area reach its full potential without adverse impacts to the transportation network.

In order to reduce the possibility of traffic disruptions and delays in the Port Covington area, enhance safety and address impacts to adjacent neighborhoods and the Port of Baltimore, the Maryland Transportation Authority (MDTA) is requesting FASTLANE grant funding to improve the infrastructure of the roadway network in the following ways:

A. **Hanover Street On-Ramp to I-95 Southbound** - The existing On-Ramp to southbound I-95 from Hanover Street will be expanded to two lanes to create better interstate access for traffic from Port Covington as well as existing northbound traffic on Hanover Street.

B. **McComas Street at Key Highway Intersection** - The existing two lane section of Key Highway will be widened to accommodate a third southbound lane in order to alleviate an existing bottleneck for traffic to/from I-95. The existing CSX bridge, which will need to be reconstructed as a result of the I-95 southbound Off-Ramp to Key Highway, will be reconstructed in order to accommodate the widening along Key Highway. This improvement will also allow for enhanced pedestrian and bicycle access along Key Highway.

C. **I-95 Southbound Off-Ramp to Key Highway** - The exit ramp to Key Highway will widen to a two-lane Off-Ramp after splitting off from I-95 to merge with McComas Street, where it will become a three-lane road, which will facilitate better traffic flow and reduce congestion from the interstate to Port Covington and the surrounding area.

D. **Hanover Street North of McComas Street** - Existing Hanover Street north of the McComas Street intersection is a four to five lane undivided roadway which is classified as a MAP-21 Principal Arterial on the Federal Highway Administration's website. The northbound outside lane drops at the gore of the Hanover Street On-Ramp to I-95 southbound. Proposed improvements include widening Hanover Street in order to accommodate the widening of the Hanover Street On-Ramp to I-95 southbound, in addition to enhanced pedestrian facilities which extend north into the surrounding residential neighborhoods.

E. **Relocated McComas Street between Hanover Street and Key Highway** - Existing McComas Street between Hanover Street and Key Highway consists of a three to four lane divided section and is classified as an Intermodal Connector on the Federal Highway Administration's website. The majority of westbound McComas Street resides under the I-95 southbound viaduct. Proposed improvements include shifting McComas Street south of I-95 in its entirety. Additional lanes will be added to the typical section in order to accommodate future traffic demand and connections to I-95. A proposed median will allow for future transit and wide sidewalks along the south side will enhance the pedestrian experience.

F. **CSX Track Relocation -** A proposed CSX track will cross over the I-95 Fort McHenry Tunnel and will act as a service track to existing Maryland Port Authority facilities. The rail relocation will allow for the existing CSX sidetrack south of I-95 to be removed which will eliminate two existing at-grade crossings within Port Covington, and prevent the creation of nine additional at-grade crossings.

The total cost of the project is $157.311 million. A FASTLANE grant of $76.1185 million is requested. The following tables are included as part of the Benefit-Cost Analysis, as described in the Benefit-Cost Analyses Guidance for FASTLANE Grant Applicants:

- **Table 1** provides a summary matrix for the Port Covington redevelopment plan improvements.

- **Table 2** summarizes the results of the BCA using the seven percent and three percent discount rates for all components of the project.

The following sections identify the assumptions and methodology used for the BCA, and sources for these assumptions. The complete Excel Workbook used for these calculations is also provided.

**Table 1: Port Covington Development Project Summary Matrix**

| Baseline and Problems to be Addressed | Change to Baseline | Impacts | Affected Population | Economic Benefit | 7% Discounted Benefits | Page |
|---|---|---|---|---|---|---|
| Limited Interstate 95 access to and from the Port Covington site | 1. Maintenance on the existing I-95 Southbound Off Ramp to Key Highway (without-project condition) | The existing ramp structure must be maintained through the 40 year period | All traffic on the I-95 Southbound Off Ramp to Key Highway | Costs associated with maintaining the existing ramp structure | Over $290,000 in additional cost | 6 |
| | 2. Additional lane on the I-95 Southbound Off Ramp to Key Highway (with-project condition) | Reduction in vehicle spill back from the I-95 Southbound Off Ramp to Key Highway | All through traffic on I-95 Southbound at the Key Highway exit | Increased benefits associated with a reduction in travel time on I-95 southbound | Over $4,500,000 in additional benefits | 10 |
| | 3. Additional diverge lane on Hanover Street northbound at the I-95 Southbound On Ramp from Hanover Street (with-project condition) | Northbound vehicles on Hanover Street can now access I-95 from two lanes, thus reducing northbound queues and travel times on Hanover Street | Northbound vehicles on Hanover Street accessing I-95 from the Southbound On Ramp from Hanover Street | Increased benefits associated with the reduction in travel time of northbound vehicles on Hanover Street to the I-95 Southbound On Ramp | Over $9,400,000 in additional benefits | 9 |
| Roadway connectivity within Port Covington as it relates to the existing CSX track | 1. Additional southbound and westbound lanes at the Key Highway at McComas Street intersection (with-project condition) | The Key Highway at McComas Street intersection will operate more efficiently | All vehicles traveling through the Key Highway at McComas Street intersection | Increased benefits associated with the reduction in delay at the intersection as it relates to travel time and fuel consumption | Over $48,000,000 in additional benefits | 10 |
| | 2. The CSX track will cross 11 roads within the Port Covington site grid (without-project condition) | The number of at-grade crossing conflicts with CSX trains will increase | All vehicles on 11 roads within the Port Covington site grid network that cross the existing CSX sidetrack | Costs associated with safety at the 11 at-grade crossings | Over $177,000 in safety costs | 9 |
| Limited Pedestrian access to and from the Port Covington site and the adjacent neighborhoods | Improve pedestrian connections and provide enhancements to existing pedestrian facilities on Hanover Street north of McComas Street and on Key Highway at McComas Street (with-project condition) | Enhanced pedestrian facilities will create a 10 percent mode split for traffic to and from the Port Covington site | Vehicles to and from the adjacent neighborhoods that will now be induced to travel on foot or by bike | Increased benefits associated with the reduced vehicle miles traveled to and from the adjacent neighborhoods and health benefits associated with the mode shift | Over $3,300,000 in additional benefits | 11 |

**Table 2: Port Covington Development Project BCA Summary**

| Long Term Outcomes | Total Net Benefits - 3% Discount Rate | Total Net Benefits - 7% Discount Rate |
|---|---|---|
| **State of Good Repair** | | |
| Maintenance of Existing | $500,110 | $363,742 |
| Maintenance of Replacement | $(202,571) | $(69,982) |
| **Subtotal Quantified Benefits State of Good Repair** | $297,539 | $293,759 |
| **Economic Competitiveness** | | |
| Oil Import Macro Costs | $7,195,386 | $2,845,590 |
| Fuel Tax | $(775,847) | $(306,827) |
| Travel Time Savings | $167,161,095 | $57,531,325 |
| **Subtotal Quantified Benefits Economic Competitiveness** | $173,580,634 | $60,070,087 |
| **Quality of Life** | | |
| Health Benefits | $6,546,552 | $2,834,063 |
| Reduction in VMT from Mode Shift | $1,120,144 | $484,905 |
| **Subtotal Quantified Benefits Environmental Sustainability** | $7,666,696 | $3,318,968 |
| **Environmental Sustainability** | | |
| VOCs | $93,992 | $37,172 |
| GHG | $1,778,221 | $1,778,221 |
| Nitrogen Oxides | $311,046 | $123,011 |
| **Subtotal Quantified Benefits Environmental Sustainability** | $2,183,259 | $1,938,403 |
| **Safety** | | |
| Crash Potential - CSX At Grade Crossings | $356,818 | $177,724 |
| **Subtotal Quantified Benefits Safety** | $356,818 | $177,724 |
| **Total Quantified Benefits** | $184,084,946 | $65,798,942 |
| **Project Cost** | $152,237,000 | $152,237,000 |
| **Benefit Cost Ratio** | **1.21** | **0.43** |

# III. Assumptions and Methodology

In the Without-Project condition, development on the Port Covington site is estimated to increase vehicular traffic to and from the area by more than 8,500 AM peak hour trips and 11,800 PM peak hour trips by project year 20. The With-Project condition assumes a 10 percent mode split due to the enhanced pedestrian connections created as part of this project. Additional trips for the With- and Without-Project conditions were projected for 8 interim years within the 20 year development build-out period based on the development program supplied to Baltimore City in order to establish the quantity of traffic on the connecting roadways and I-95 ramps. Year 20 volumes were then held constant through the full 40 year useful life evaluation period. These volume assumptions do not take into account forecasted increases in regional traffic; however, additional increases in background traffic would only increase the forecasted congestion so this is a conservative assumption. Off peak hour volumes at the Hanover Street at McComas Street and Key Highway at McComas Street intersections were generated as a percentage of PM peak hour traffic. This percentage was calculated based on 24-hour traffic count data for the I-95 southbound off-ramp and I-95 southbound on-ramp conducted by MdTA in 2015. The following sections summarize the assumptions and methodology used for comparing monetary benefits with and without the project.

All referenced traffic analysis on can be found on the MDTA website at the following web address:

http://www.mdta.maryland.gov/Capital_Projects/FASTLANE.html

# Without-Project Condition

## A. Maintenance Costs

### I-95 Southbound Off-Ramp to Key Highway

An estimate is made for the costs associated with maintaining the existing ramp structure versus constructing and maintaining a new ramp structure. Based on information from the Maryland Transportation Authority (MDTA), yearly maintenance on the existing structure does not occur, but the years 2016 and 2031 are anticipated to include maintenance costs associated with this structure and are estimated at $243,498.91 in each of the two years specified, while a new structure would not require major overhaul for the first 20 years. It was assumed that a similar 15 year major maintenance cycle would be needed thereafter.

## B. Value of Travel Time

### Hanover Street On-Ramp to I-95 Southbound

The Without-Project condition assumes that the existing I-95 Southbound access from Hanover Street is maintained. Quantitative benefits based on the amount of delay experienced by

northbound vehicular traffic at the Hanover Street at McComas Street intersection were calculated. VISSIM 8 software was used to determine the delay per vehicle during the AM and PM peak hours and a subset of off peak hours, as described in the Assumptions and Methodology introduction.

The four off peak hours evaluated were chosen based on traffic projections for the I-95 southbound on-ramp north of the intersection. These projections, as shown in Figure 1, indicate that the Port Covington development would increase traffic on this on-ramp substantially. The Highway Capacity Manual defines ramp capacity for a one lane loop ramp operating at LOS B as 1,050 vehicles per hour. Twenty-four hour projections for the Without-Project condition show that a ramp capacity of 1,050 would be exceeded during the AM and PM peak hours and four additional hours during a typical weekday.

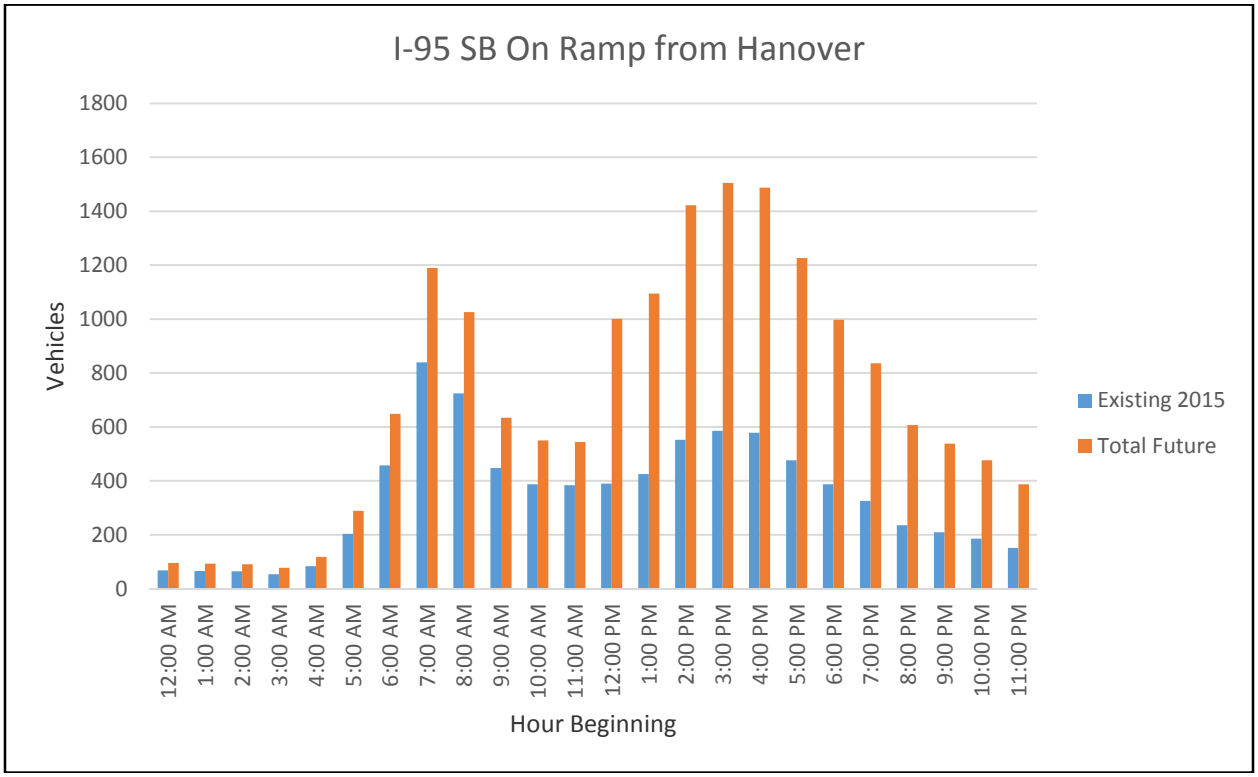


**Figure 1: I-95 Southbound On Ramp from Hanover Street Existing and Future Traffic Projections**

### McComas Street at Key Highway Intersection

The Without-Project condition assumes the existing lane configuration at the McComas Street at Key Highway intersection. Smaller improvements to this intersection are not possible due to the physical constraints of the CSX bridge and I-95 piers, creating a pinch-point in the network. The amount of delay experienced by westbound vehicles at the intersection was calculated and monetized based on guidance from the BCA Resource Guide. Synchro 8 software was used to determine the delay per vehicle during the AM and PM peak hours and a subset of off peak hours. Synchro outputs are

The five off peak hours evaluated were chosen based on traffic projections for the I-95 southbound off-ramp east of the intersection. The Port Covington development will increase traffic substantially at this location over the 40 year period due to this being the only southbound off-ramp that accesses the Port Covington peninsula. These projections, as shown in Figure 2, indicate that five hours, in addition to the AM and PM peak hours, significantly exceed 1,000 vehicles per hour during a typical weekday. It is assumed that all hours with less than 1,000 vehicles per hour are not experiencing congestion, and were therefore not included.

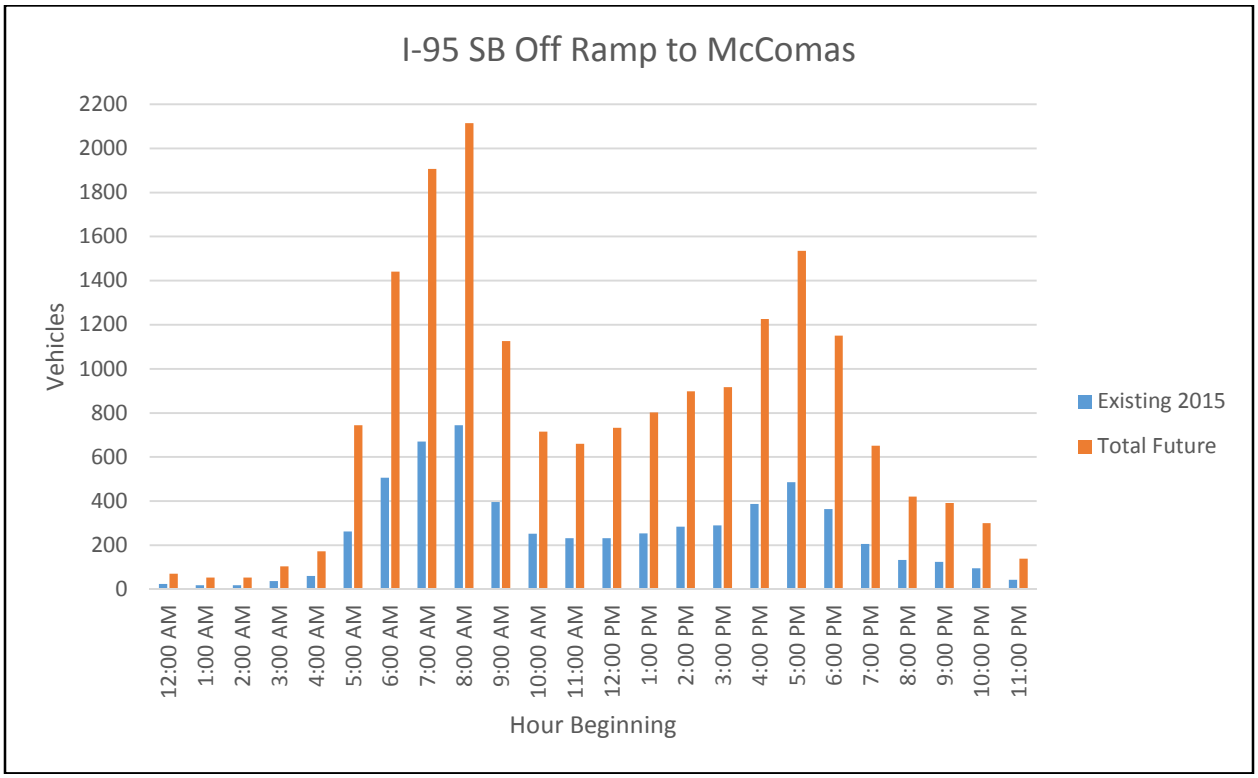


**Figure 2: I-95 Southbound Off Ramp to McComas Street Existing and Future Traffic Projections**

### Impacts to I-95 Southbound

In the Without-Project condition, the westbound vehicular delays at the McComas Street at Key Highway intersection are so excessive that the westbound vehicular queue is anticipated to spill back onto I-95 southbound. Each of the interim volume conditions evaluated were modeled in VISSIM 8 software to determine which years would cause substantial impact to through vehicles on I-95 southbound. Without the *Access I-95* project, queues on the I-95 southbound off ramp begin spilling back onto the interstate and impacting through vehicles on I-95 southbound in 2029 and beyond.

## C. Value of Emissions

An estimate was made for the fuel consumed associated with the increase in vehicular delay at the McComas Street at Key Highway intersection in the without-project scenario. Synchro 8 software

outputs provided the amount of fuel consumed for the westbound approach of the intersection for the AM, PM, and off peak hours during the 40 year time period. The amount of fuel consumed was then converted to different emissions types including nitrogen oxides, volatile organic compounds (VOCs), and carbon dioxide, and was then monetized based on values outlined in the 2016 BCA Resource Guide.

### D. Value of Safety at At-Grade Crossings

An estimate was made for the increase in predicted crashes associated with the increase in at-grade crossings for the CSX track on the subject site in the without-project scenario. There are two existing at-grade CSX crossings south of I-95, and without the project, nine additional at-grade crossings would be created, thus increasing vehicle-rail conflicts and the potential for crashes. Based on the dispersion of site traffic over the two existing and nine future at-grade crossings without the project, the predicted crash ratio per year for each roadway was calculated. These crash ratios were then converted to a predicted number of fatal, injury, and property damage crashes and monetized based on values outlined in the 2016 BCA Resource Guide.

In addition to the at-grade crossings south of I-95, the CSX track has an existing crossing within the project vicinity at Andre Street. The predicted crash ratio for this crossing was obtained from the Federal Railroad Administration based on the crash records from 2011 through 2014. This crash ratio was then converted to a predicted number of fatal, injury, and property damage crashes and monetized based on values outlined in the 2016 BCA Resource Guide.

## With-Project Condition

### A. Maintenance Costs

#### I-95 Southbound Off-Ramp to Key Highway

In the with-project scenario, the I-95 southbound off ramp to Key Highway is widened to two lanes. Based on information from MDTA, there would be no necessarily yearly maintenance costs for the new structure for the first 20 years of use. It was assumed that after the initial 20 years a 15 year maintenance interval would be required, similar to the without-project condition.

### B. Value of Travel Time

#### Hanover Street On-Ramp to I-95 Southbound

The project is anticipated to increase the Port Covington development mode split to 10 percent due to the increased connectivity to the adjacent neighborhoods. Therefore, the with-project condition has a reduction in vehicular trips when compared to the without-project condition. Additionally, the project proposes a second diverge lane to the I-95 southbound on-ramp north of the Hanover Street at McComas Street intersection. This additional lane will reduce the amount of delay and queuing experienced by northbound vehicles on Hanover Street. Quantitative benefits based on the amount of delay experienced by northbound vehicular traffic at the Hanover Street at McComas

Street intersection were calculated using VISSIM 8 software to determine the delay per vehicle during the AM, PM, and off peak hours on a typical weekday. The difference in delay per vehicle between the with- and without-project scenarios was converted to person-hours saved with the project and was monetized based on values outlined in the 2016 BCA Resource Guide.

### McComas Street at Key Highway Intersection

As stated above, the with-project scenario includes a 10 percent mode split for the Port Covington development to account for the increased connectivity to adjacent neighborhoods associated with enhancing pedestrian facilities as part of this project. The with-project scenario includes the widening of the I-95 southbound off-ramp to Key Highway and additional westbound and southbound right-turn lanes at the McComas Street at Key Highway intersection. Quantitative benefits for the reduced vehicular trips based on the amount of delay experienced by westbound vehicular traffic at the intersection were calculated using Synchro 8 software to determine the delay per vehicle during the AM, PM, and off peak hours on a typical weekday. The difference in delay per vehicle between the with- and without-project scenarios was converted to person-hours saved with the project and was monetized based on values outlined in the 2016 BCA Resource Guide.

### Impacts to I-95 Southbound

As stated above, the westbound delays at the McComas Street at Key Highway intersection for the without-project scenario are so excessive that the I-95 southbound off-ramp queues exceed the available capacity and spill back onto the interstate in 2029 and beyond. The with-project scenario includes additional lanes at the McComas Street at Key Highway intersection and widening of the I-95 southbound off-ramp past the gore which reduces delays and queues on the ramp. The difference in travel time for through vehicles on I-95 southbound was calculated using VISSIM 8 software, and converted to person-hours saved with the project and was monetized based on values outlined in the 2016 BCA resource guide.

## C. Value of Emissions

An estimate was made for the decrease in fuel consumption associated with the decrease in vehicular delay at the McComas Street at Key Highway intersection in the with-project scenario. Synchro 8 software outputs provided the amount of fuel consumed for the westbound approach of the intersection for the AM, PM, and off peak hours during the 40 year time period. The difference in the amount of fuel consumed between the with- and without-project scenarios was then converted to different emissions types including nitrogen oxides, volatile organic compounds (VOCs), and carbon dioxide, and was then monetized based on values outlined in the 2016 BCA Resource Guide.

In addition to the above assumptions for vehicle emissions, an estimate was made for the savings associated with the macro-economic cost of oil imports based on the difference in fuel consumption for all vehicles with and without the project. The US Energy Information Administration estimates the dollar per gallon for US oil imports at $2.52 for 2015[(2)]. In addition to the above savings, the amount of Federal fuel taxes lost resulting from the reduction in VMT were estimated based on US tax rates of 18.4 cents per gallon for gasoline in 1997[(3)]. This value

was then converted to 2015 dollars using the Bureau of Labor Statistics CPI calculator[4].and the fuel tax costs were subtracted from the savings on oil imports.

## D. Value of Safety at At-Grade Crossings

In the with-project scenario, all at grade crossings within the Port Covington development area are eliminated due to the construction of the proposed CSX track over the I-95 Fort McHenry Tunnel. The only at-grade crossing for this track in the site vicinity is an existing crossing at Andre Street. An estimate was made for the increase in predicted crashes associated with an increase in the number of trains per day at this crossing. The number of trains per day at this crossing increases due to the existing trains on the sidetrack south of I-95 being rerouted to the relocated track north of I-95 to access the Maryland Port Authorities. The crash ratio for the Andre Street crossing was then converted to a predicted number of fatal, injury, and property damage crashes and monetized based on values outlined in the 2016 BCA Resource Guide.

## E. Value of Health Savings

An estimate was made for the economic savings for health care, workers' compensation, and lost productivity associated with the shift in mode of travel due to the enhanced pedestrian connections to the adjacent neighborhoods in the with-project scenario. A health savings multiplier was calculated based on guidance from a 2005 study conducted for the California Department of Health Services[5] and the percent of inactive adults in Maryland[6]. The 10 percent pedestrians in the with-project scenario were divided into annual users (8 percent) and casual users (2 percent). The annual users are considered commuters that are transitioning from an inactive lifestyle to an active style. The casual users use the pedestrian facilities fewer times per year and the health savings multiplier is discounted by 50 percent to account for the less frequent use.

## F. Value of Vehicle Miles Traveled

An estimate was made for the amount of vehicle miles saved due to a mode shift from driving to walking associated with the enhanced pedestrian facilities that will connect Port Covington to the adjacent neighborhoods in the with-project scenario. The with-project scenario assumes that 10 percent of Port Covington site trips will access the site by walking or other active mode. An average distance of 1 vehicle-mile is saved for the 10 percent of trips made by pedestrians. The VMT savings with the project are calculated based on the Federal Highway Cost Responsibility tables[7], which show per mile values for converting VMT to monetary benefits for pavement wear, congestion, crash avoidance, noise pollution, and air pollution (other than $CO_2$). The values for automobiles on urban interstates were used. The values are listed in year 2000 dollars and were converted to 2015 dollars using the Bureau of Labor Statistics CPI calculator[4].

## Reference List


1. BCA Guidance for FASTLANE Applicants
   https://www.transportation.gov/fastlanegrants/bca-and-project-readiness-guidance

2. Yearly US oil import information.
   http://www.eia.gov/dnav/pet/pet_pri_gnd_dcus_nus_a.htm

3. Federal Highway Administration US Fuel Taxes
   http://www.fhwa.dot.gov/infrastructure/gastax.cfm

4. Bureau of Labor Statistics CPI calculator
   http://www.bls.gov/data/inflation_calculator.htm

5. The Economic Costs of Physical Inactivity, Obesity, and Overweight in California Adults
   https://www.cdph.ca.gov/HealthInfo/healthyliving/nutrition/Documents/CostofObesityToplineReport.pdf

6. Inactivity in Adults by State
   http://stateofobesity.org/physical-inactivity/

7. Addendum to the 1997 Federal Highway Cost Allocation Study Final Report, U.S. Department of Transportation, Federal Highway Administration, May 2000
   http://www.fhwa.dot.gov/policy/hcas/addendum.htm